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Ultrasound guided pericapsular nerve group block and fascia iliaca block in pediatric hip surgery

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Abstract

Surgeries that influence the hip joint in children are accompanied by intense pain during and after the procedure, even when systemic opiates are administered. An effective strategy for managing pain in children involves using many methods simultaneously. Whenever feasible, it is advisable to use localized analgesia in conjunction with a mix of systemic medications instead of depending on a single medication. The fascia iliaca block decreases the need for systemic analgesics, which include opioids and non-steroidal anti-inflammatory medicines, and mitigates their adverse effects. The pericapsular nerve group blocking offers pain relief after thigh or hip injuries or procedures, such as mid-shaft or femoral neck fractures, acetabular fractures, hip arthroscopy, and hip replacement.

Keywords: Ultrasound guided pericapsular, fascia Iliaca block, pediatric hip surgery

Introduction

Postoperative discomfort after paediatric hip and femoral shaft operations is often accompanied by significant complications and might impede the rehabilitation process in children. Traditionally, postoperative pain has been treated with systemic opioids and neuraxial analgesia. Nevertheless, the implementation of these methods is limited due to the potential risks of hemodynamic instability, respiratory depression, motor block, pruritis, and postoperative vomiting and nausea^[1]. Regional anaesthesia methods may be a very effective choice for providing pain relief following surgeries on the hip in children by blocking the femoral, obturator, and sciatic nerves^[2]. Various ultrasound-guided regional anaesthesia procedures, which include femoral nerve block, lumbar plexus block, and fascia iliaca compartment block, are utilised for managing acute pain in hip surgery while minimizing adverse effects^[3].

The fascia iliaca compartment block (FICB) is a widely used regional anaesthetic method for surgical operations that include the hip joint and femur^[4].

The PENG block was developed to anaesthetize the articular branches of the femoral, obturator, and accessory obturator nerves, that supply sensory innervation to the hip^[5].

Postoperative pain in pediatric hip surgery

Postoperative discomfort after paediatric hip and femoral shaft operations is often accompanied by significant complications and may lead to delays in child rehabilitation^[6].

Management of post-operative pain in pediatric hip surgery

There are several approaches for managing pain in children. The treatment options include general measures, systemic pharmacotherapy, and localized methods. Effective management of pain in children necessitates the use of many methods. Whenever feasible, it is advisable to use localized analgesia in conjunction with a mix of systemic medications rather than depending only on a single medication^[7].

I. General measures: These methods include the existence of a parent with the kid, nursing in a conducive setting, letting the infant to assume the most comfortable posture, and feeding if it is allowed^[8].

II. Systemic drug therapy

A. Non-opioid analgesics

- 1. Paracetamol:** The method of action involves inhibiting the formation of prostaglandin and substance-P, as well as regulating the generation of nitric oxide. The paracetamol pharmacokinetics remain consistent between the ages of 18 months and 18 years^[9].
- 2. Non-Steroidal Anti-Inflammatory Drugs (NSAIDs):** are medications that limit the formation of prostaglandins by blocking the enzymes COX-1 and COX-2. They are efficacious in all forms of pain, including inflammatory, mechanical, and visceral pain^[9].
- 3. ALPHA-2 Adrenergic Receptor Agonists:** are employed in the perioperative multimodal pain treatment. They function by activating α -2 receptors located in the spinal cord' posterior horn and also in the locus coeruleus, which is located above the spinal cord. This activation leads to the inhibition of the release of substance and P glutamate^[9].
- 4. Ketamine:** demonstrates a multifaceted method of action. It hinders the triggering of the NMDA receptor, causes pain relief, and stops the development of long-lasting postoperative pain^[9].
- 5. Gabapentinoids:** namely pregabalin and gabapentin, are utilised for the management of persistent neuropathic pain among children and adolescents. These medicines have been used into multimodal analgesia during the perioperative phase as part of premedication^[9].

B. Opioid analgesics

- 1. Morphine:** is the predominant μ agonist in therapeutic practice. The morphine' pharmacokinetics in children closely resemble those in adults. Neonates are an exception since morphine dosages needed to be decreased due to underdeveloped liver and kidney function^[9].
- 2. Fentanyl:** although being metabolised into inactive metabolites, has a far greater analgesic impact compared to morphine, with a potency that is 100 times higher. It is often administered via several methods such as intravenous, transmucosal, inhalational, transdermal, and intra-nasal for managing procedural pain during surgery. This is because it has a fast onset and offset^[9].
- 3. Tramadol:** has lower potency compared to codeine or morphine. Usage of this product is prohibited for children under the age of 12 due to lack of licencing. The medication may be administered orally to children aged 12-18 years at a dosage of 2 mg per kilogramme of body weight, up to a maximum of four times per day^[9].
- 4. Nalbuphine:** is a suggested medication for alleviating pain that is mild to moderate in severity. It is often given by an iv route, with a dosage of 0.1-0.2 mg/kg every 3-6 hours. Alternatively, it may be provided as an infusion at a pace of 0.05-0.1 mg/kg/h^[9].

III. Regional techniques: might be a beneficial choice for providing pain relief following surgeries on the hip among children.

They are divided into central neuroaxial blocks like caudal epidural block or peripheral block through the blockage of obturator, femoral, and sciatic nerves like lumbar plexus block, FICB and PENG block^[10].

FICB in pediatric hip surgery

Historically, the FICB was performed employing a straightforward method that relied on landmarks for guidance. Ultrasound guiding has becoming widely used. Ultrasound has also made it easier for developing closer, suprainguinal procedures to the FICB. The reason for the effective blocking of the lateral cutaneous nerve of the thigh and obturator nerve is the distribution of local anaesthetic towards the proximal direction. This is due to both of these nerves are often located above the fascia iliaca, which is situated below the inguinal ligament^[4].

A. Ultrasound guided infrainguinal approach

The patient is positioned in a supine posture, and a probe is positioned transversely to locate the femoral artery at the crease of the groin. Following the cleaning of the skin and the injection of local anaesthesia, a needle with a rounded tip is inserted utilising a method that follows the same plane as the target area. The goal is to position the tip of the needle below the fascia iliaca, namely in the lateral third of a line connecting the pubic tubercle and the ASIS^[4].

B. Ultrasound guided suprainguinal approach

In 2011, Hebbard introduced longitudinal suprainguinal technique that guided by the sonography to the FICB in research using cadavers. In this procedure, the patient is lying on their back, and the ultrasound probe is positioned sagittally to get a picture of the ilium and iliacus muscle. The needle is placed 2–4 cm below the inguinal ligament, with the goal of positioning it under the fascia iliaca, above the inguinal ligament. The authors stated that this methodology has the potential for offering a more precise method for the FICB, resulting in lower needs for local anaesthetic volume and making it easier to implant the FICB catheter. The research did not report the spread of LA to the ON^[4]. The suprainguinal technique to the FICB has also been documented employing a needle insertion position that is closer to the origin of the structure. When the patient is lying on their back, the probe is positioned in the sagittal plane to capture an image of the ASIS. The probe is repositioned towards the midline, allowing for the identification of the fascia iliaca, as well as the iliopsoas, sartorius, and internal oblique muscles. The needle is inserted 1 cm above the inguinal ligament. utilising an in-plane technique, the needle tip is placed below the fascia iliaca, and hydro-dissection proceeds to create a separation between the iliacus muscle and the fascia iliaca^[4, 11].

Complications^[4].

- Injection into a blood vessel.
- Toxicity of local anaesthetics.
- Transient or enduring nerve impairment.
- Transmission of infectious microorganisms.
- Failed blockage.

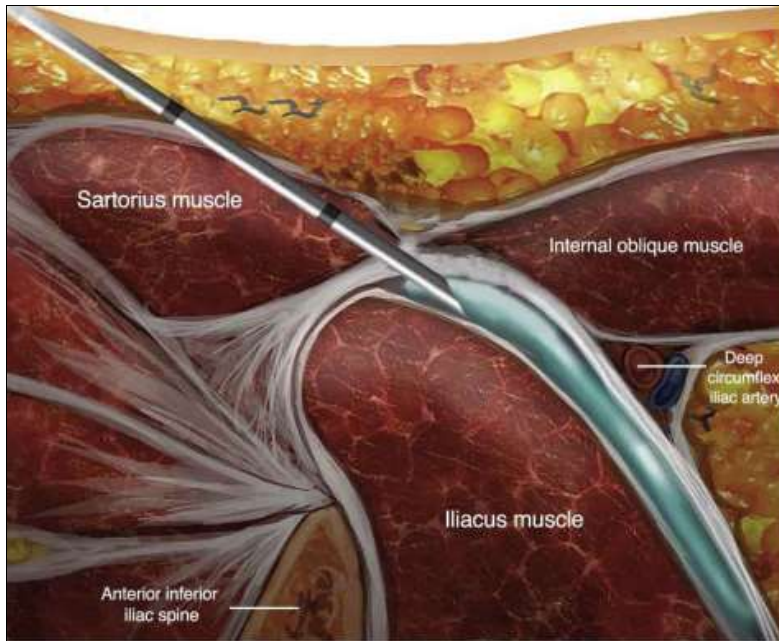
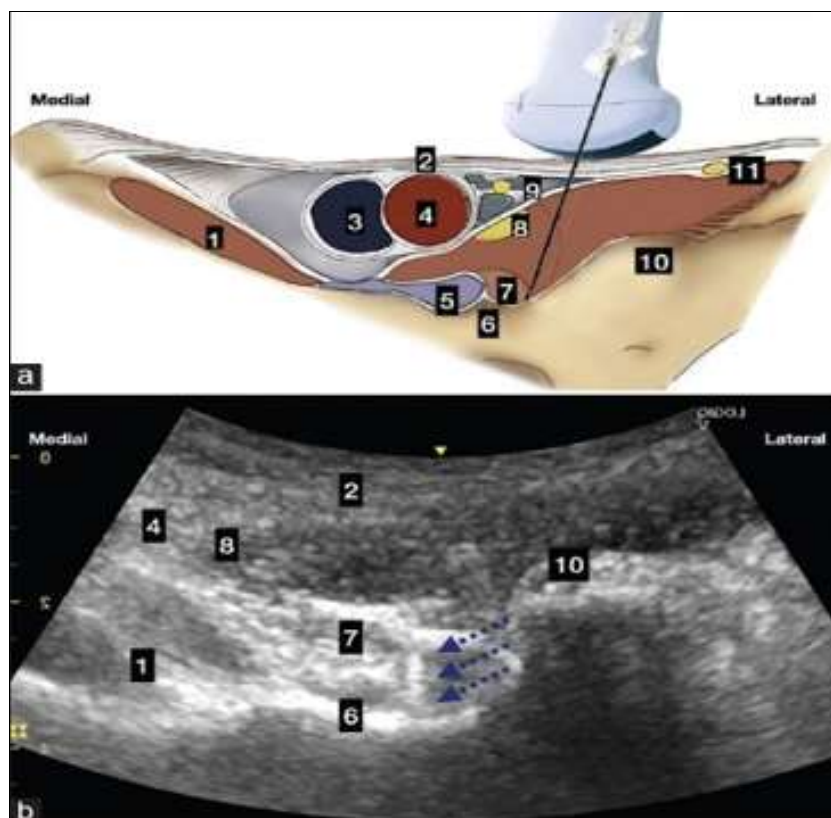


Fig 1: Schematic of the fascia iliaca compartment in suprainguinal approach ^[11]

PENG Block in pediatric hip surgery: It specifically targets the nerves that feed the hip's anterior capsule, with the goal of minimizing discomfort following hip surgeries and fractures ^[12]. The PENG block is the suprainguinal version of the articular branches of the femoral nerve with the added benefit of blocking the accessory obturator nerve along with the obturator nerve ^[13].

The PENG Block is performed only under ultrasound guidance, there are two techniques

A. Out-of-plane Technique: The patient is positioned in a supine posture with the hip in an extended posture. Following aseptic preparation, position the probe at the ASIS level. Align the probe parallel to the inguinal fold, ensuring that the pubic ramus is centred in the picture for accurate targeting. An ultrasound-guided out-of-plane approach may be used to provide local anaesthetic by introducing a nerve block needle ^[14, 15]. (Figure 2)



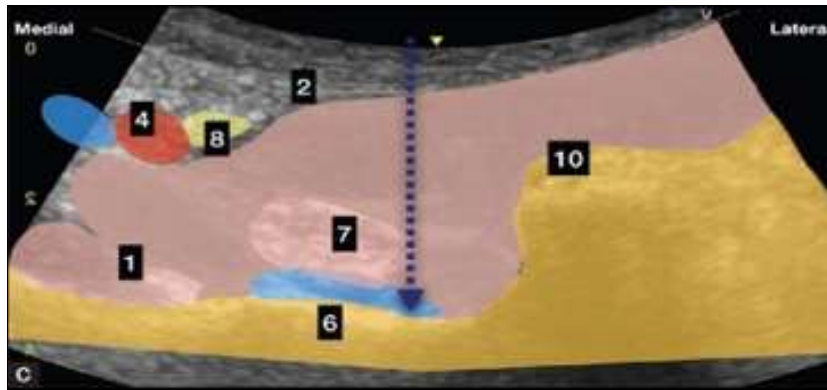


Fig 2: Out-of-plane PENG block scheme (a). Out-of-plane PENG block: sonographic image (b and c). (1) Pectineus muscle, (2) inguinal ligament, (3) femoral vein, (4) femoral artery, (5) iliopectineal bursa, (6) iliopectineal eminence, (7) psoas tendon, (8) femoral nerve, (9) genitofemoral nerve, (10) anteroinferior iliac spine and (11) lateral femoral cutaneous nerve. Arrows in (b): needle tip. Arrow in (c): needle trajectory ^[15]

B. In-plane Technique

The transducer is positioned in the transverse plane above the AIIS and then adjusted downwards to provide a clear view of the pubic ramus. Through the use of an in-plane

approach, the nerve block needle is inserted through the skin in a lateral-to-medial direction. An injection of local anaesthetic is administered in the space between the pubic ramus and psoas tendon ^[16]. (Figure 3)

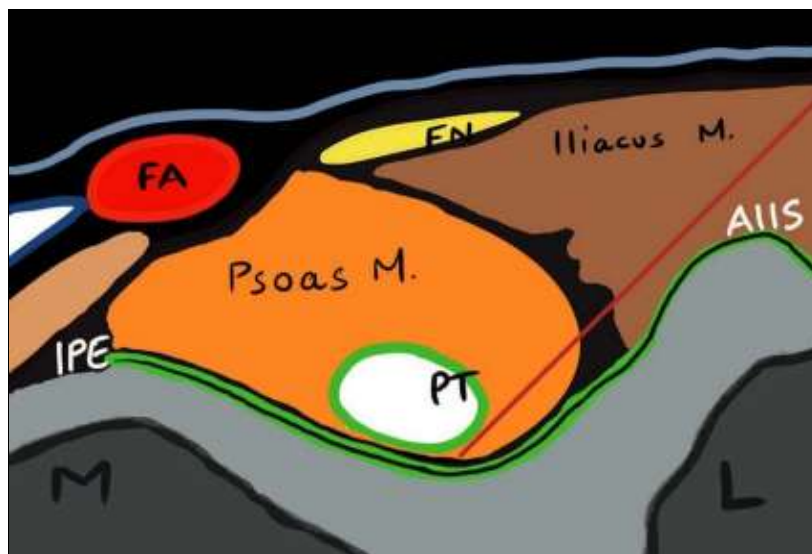


Fig 3: Diagrammatic approach of pericapsular nerve group block. AIIS indicates anterior inferior iliac spine; FN, femoral nerve; FA, femoral artery; IPE, iliopubic eminence; M, medial; L, lateral; PT, psoas tendon ^[16]

Complications

A comprehensive understanding of the possible problems connected with a certain surgery is necessary for regional anaesthesia approaches. Possible risks of peripheral nerve blocks including infections, haemorrhage, nerve injury, and toxicity from the local anaesthetic. The systemic toxicity of local anaesthetics is caused by either injecting them into the bloodstream or administering a dosage that exceeds the safe limits. The management strategy for this emergency involves promptly administering iv intralipid and implementing hemodynamic supportive measures. The use of the PENG block only under the guidance of ultrasonography has significantly minimised the occurrence of femoral nerve injury or vascular damage, including hematoma formation, which is now very uncommon. The prevalence of long-lasting peripheral nerve injury is around 0.02% to 0.04% of peripheral nerve blocks of any kind ^[17].

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